

METHODS AND SYSTEMS FOR DISPLAYING ASSISTANCE MESSAGES TO AIRCRAFT OPERATORS

TECHNICAL FIELD

[0001] The present invention relates generally to methods and systems for displaying assistance messages to aircraft operators, for example, methods and systems for displaying instructions and/or examples of correct inputs upon receiving incorrect inputs at an aircraft flight deck.

BACKGROUND

[0002] As modern aircraft have become increasingly complex, aircraft flight controls have made increasing use of computer systems to organize and simplify the pilot's workload. Accordingly, modern aircraft include computer keyboards, cursor control devices, displays and other input/output devices that accept commands and data entered by the pilots and display this information to the pilots. For example, Figure 1A illustrates a conventional control display unit (CDU) 30 having input devices 31 (e.g., keyboard keys) and a display screen 35 for displaying data. The display screen 35 can include a preview field 32 that displays information as the pilot enters keystrokes with the input devices 31. For example, in response to a system request to input an airport identifier, the pilot has entered the character string "X34A," which appears in the preview field 32 shown in Figure 1A.

[0003] When the pilot's entry is erroneous (as it is in Figure 1A, because an airport identifier should not include any numbers), the pilot is notified in a manner shown in Figure 1B. In particular, the pilot's entry at the preview field 32 is overwritten by the text "INVALID ENTRY." Overwriting the pilot's entry with a short message is

necessitated by the fact that space available for pilot displays (and in particular, the space available at the display screen 35 of the CDU 30) is extremely limited. However, this approach suffers from at least two drawbacks. First, once the message "INVALID ENTRY" is displayed, the pilot can no longer see the input that prompted the error message. Accordingly, the pilot cannot review the input to determine what prompted the error message. Second, while the error message makes clear that the pilot made an invalid entry, it does not provide the pilot with any guidance for correcting the error. Accordingly, the pilot's attempts to correct the error may be conducted by trial and error, which can be time consuming.

SUMMARY

[0004] The present invention is directed toward methods and systems for handling aircraft operator inputs. A method in accordance with one embodiment of the invention includes receiving an input from an aircraft operator at an aircraft flight deck and comparing a characteristic of the input to at least one target value of the characteristic. If the characteristic of the input differs from the at least one target value for the characteristic by at least a threshold amount, the method can further include displaying an assistance message to the aircraft operator. The assistance message can include at least one of a complying input and an instruction for creating a complying input.

[0005] In particular embodiments of the invention, comparing the characteristic of the input can include comparing a format of the input to a target format, comparing a number of characters in a character string to a target number of characters, comparing a type of character in a character string to a target type of character, and/or comparing a numerical value to a target numerical value. The method can further include displaying the same assistance message for all non-complying inputs provided to fulfill data requests of a predetermined type. In further embodiments, the method can further include displaying a first assistance message for non-complying inputs provided to fulfill data requests of a first type and displaying a second assistance message different than the first for non-

complying messages provided in response to a data request of a second type different than the first type.

[0006] A system for handling aircraft operator inputs in accordance with another embodiment of the invention includes a receiving portion configured to receive an input from an aircraft operator at an aircraft flight deck, and a comparing portion operatively coupled to the receiving portion to compare a characteristic of the input to at least one target value for the characteristic. A display portion can be operatively coupled to the comparing portion to display an assistance message to the aircraft operator if the characteristic of the input differs from the at least one target value by at least a threshold amount. The assistance message can include at least one of a complying input and an instruction for creating a complying input.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] Figures 1A-1B illustrate a control display unit configured to display error messages in accordance with the prior art.

[0008] Figure 2 is a flow diagram illustrating a method for providing assistance messages to an aircraft operator in accordance with an embodiment of the invention.

[0009] Figure 3 is a partially schematic illustration of aircraft flight deck components configured to display assistance messages in accordance with an embodiment of the invention.

[0010] Figure 4 is a flow diagram illustrating a method for displaying assistance messages in accordance with another embodiment of the invention.

[0011] Figure 5 is an illustration of a multifunction display panel or screen presenting an assistance message corresponding to an invalid entry for an airport identifier in accordance with an embodiment of the invention.

[0012] Figure 6 is an illustration of a multifunction display panel or screen presenting an assistance message corresponding to an invalid airplane weight in accordance with an embodiment of the invention.

[0013] Figure 7 is an illustration of a multifunction display panel or screen presenting an assistance message corresponding to an invalid airline entry in accordance with still another embodiment of the invention.

[0014] Figure 8 illustrates a flight deck having input devices and display panels or screens on which assistance messages can be displayed in accordance with still further embodiments of the invention.

DETAILED DESCRIPTION

[0015] The following disclosure describes systems and methods for providing assistance to aircraft operators who input information into onboard aircraft computers, for example, flight guidance computers. Certain specific details are set forth in the following description and in Figures 2-8 to provide a thorough understanding of various embodiments of the invention. Well-known structures, systems and methods often associated with these aircraft systems have not been shown or described in detail to avoid unnecessarily obscuring the description of the various embodiments of the invention. Those of ordinary skill in the relevant art will understand that additional embodiments of the present invention may be practiced without several of the details described below.

[0016] Many embodiments of the invention described below may take the form of computer-executable instructions, including routines executed by a programmable computer (e.g., a flight guidance computer or a computer linked to a flight guidance computer). Those skilled in the relevant art will appreciate that the invention can be practiced with other computer system configurations as well. The invention can be embodied in a special-purpose computer or data processor that is specifically programmed, configured or constructed to perform one or more of the computer-executable instructions described below. Accordingly, the term "computer" as generally used herein refers to any data processor and includes Internet appliances, hand-held devices (including palm-top computers, wearable computers, cellular or mobile phones, multi-processor systems, processor-based

or programmable consumer electronics, network computers, minicomputers and the like).

[0017] The invention can also be practiced in distributed computing environments, where tasks or modules are performed by remote processing devices that are linked through a communications network. In a distributed computing environment, program modules or subroutines may be located in both local and remote memory storage devices. Aspects of the invention described below may be stored or distributed on computer-readable media, including magnetic and optically readable and removable computer disks, as well as distributed electronically over networks. Data structures and transmissions of data particular to aspects of the invention are also encompassed within the scope of the invention.

[0018] Figure 2 is a flow chart illustrating a process 200 for providing assistance to an aircraft operator in accordance with an embodiment of the invention. In process portion 202, the process 200 can include receiving an input from an aircraft operator at an aircraft flight deck. For example, process portion 202 can include receiving information entered by the operator at a keyboard, with the information corresponding to a departure airport, en route way point, aircraft weight, or any of a wide variety of other data associated with aircraft flight operations.

[0019] In process portion 204, the process 200 can include comparing a characteristic of the input to at least one target value for the characteristic. For example, process portion 204 can include comparing a number of characters in a character string to the number of characters for an acceptable or complying character string, and/or comparing a numerical value of the input to an acceptable or complying range of numerical values for that type of input. If the characteristic of the input differs from the at least one target value for that characteristic by at least a threshold amount, the process can include displaying an assistance message to the aircraft operator (process portion 206). The assistance message can include a complying input and/or an instruction for creating a complying input.

For example, the assistance message can include a list of sample inputs that meet the target value for the characteristic of that input, and/or a textual description of the attributes of a complying input.

[0020] The foregoing process may be carried out by routines, subroutines, and/or other computer-based processes. Accordingly, the process of receiving an input from an aircraft operator can be performed by a receiving portion of an aircraft system, comparing a characteristic of the input can be performed by a comparing portion of the system, and displaying an assistance message can be carried out by a displaying portion of the system. In other embodiments, other portions of the system can perform these and/or other functions in combinations other than those described above.

[0021] Figure 3 illustrates a system 310 having components configured in accordance with one embodiment of the invention to carry out the process 200 described above with reference to Figure 2. The system 310 can include a plurality of devices for receiving inputs from the operator, displaying the inputs to the operator, and also displaying assistance messages to the operator if the operator's input is incorrect or non-compliant. For example, the system 310 can include a control display unit (CDU) 330 having a display screen 335 and multiple input devices 331 (e.g., alphanumeric input keys). The display screen 335 can include a preview field or scratch pad 332 at which the operator's input is displayed, and an assistance message field 333 which displays assistance messages if the operator's input is incorrect. Accordingly, the display screen 335 can be made larger than conventional CDU display screens, and/or the information presented on the display screen 335 can be compressed, and/or some information conventionally presented at the CDU 330 can be eliminated. In any of these embodiments, once the system 310 processes the input and determines that input is compliant, the input can be entered and displayed at an active input field 338. The input can then be activated automatically or after the operator provides an additional input requesting activation. The activated input

can become part of a flight plan and/or can direct a change in a characteristic of the aircraft (e.g., the aircraft speed, direction and/or altitude).

[0022] The functions provided by the input devices 331, the preview field 332 and the assistance message field 333 can be distributed over other devices of the system 310, in addition to or in lieu of the CDU 330. For example, the system 310 can include a plurality of multifunction displays (MFDs) 340, shown as a first multifunction display 340a and a second multifunction display 340b. Each multifunction display 340 can include a screen 345 large enough to accommodate a preview field 342 (shown as first and second preview fields 342a, 342b), an assistance message field 343 (shown as first and second assistance message fields 343a, 343b) and an active input field 348 (shown as first and second active input fields 348a, 348b).

[0023] The first MFD 340a can be configured to emulate the display presented by the CDU 330, and can accordingly further include an emulated CDU display 344. The emulated CDU display 344 is larger than a conventional CDU display so as to accommodate the first assistance message field 343a. Further details of MFDs, including MFDs configured to emulate CDU displays are provided in co-pending U.S. Application No. _____, (Attorney Docket No. 03004.8140US) entitled "Systems and Methods for Handling the Display and Receipt of Aircraft Control Information," and U.S. Application No. _____, (Attorney Docket No. 03004.8139US) entitled "Methods and Systems for Controlling the Display of Information at an Aircraft Flight Deck," both filed concurrently herewith and both incorporated herein in their entireties by reference.

[0024] The input data appearing in the first preview field 342a can be provided by the input devices 331 of the CDU 330 or by other devices. For example, the system 310 can include a detached keyboard 350 having input devices (e.g., alphanumeric input keys) 351 that allow the operator to input data. The input data can appear in a preview field 352 of the detached keyboard 350, and can simultaneously appear at any of the other preview fields shown in Figure 3. In

another embodiment, the operator can use a cursor control device 380 or another device to input data and/or transfer data from a preview field of one device to preview field of another device. In any of these embodiments, the operator can submit the input data for processing and entry, also by activating the cursor control device 380 or another input device (e.g., the input devices 331, 351).

[0025] In any of the arrangements described above with reference to Figure 3, the operator can input data at a preview field and, if the data are incorrect, the operator can receive an assistance message while the data in the preview field are still visible. In a particular aspect of these embodiments, the assistance message can appear at a position at least proximate to the preview field so that the operator can simultaneously view both the erroneous input and the assistance message without having to move his or her eyes over a wide spatial range. Further details of the operation of the system 310 are described below with reference to Figure 4-8.

[0026] Figure 4 illustrates further details of an embodiment of the process 200 described above with reference to Figure 2. Receiving an input from an aircraft operator (process portion 202) can include checking for data at a scratch pad or other preview field (process portion 401) and detecting a signal (e.g., cursor click or other switch action) indicating that the operator wishes to submit or enter the data appearing at the preview field (process portion 403). In process portion 405, the entered data are compared to rules, guidelines or target values for data that are received at a particular field (e.g., a particular preview field) and are to be directed to a particular field, for example, a particular active input field. In process portion 407, the process 200 includes determining whether or not the entered data satisfy the rule(s). If they do, the data can be entered, for example, by moving the data to an active input field (process portion 408). The assistance message, if there is one, can be cleared or removed. If the data do not satisfy the rule(s), then in process portion 409, the data are not loaded to an active input field and instead an appropriate assistance message is obtained, for example, from a lookup table. The assistance message is then transmitted to any of the assistance message

fields described above with reference to Figure 3 (process portion 411). Once the assistance message has been transmitted, the process 200 returns to process portion 403 to await an updated data entry by the operator. This process continues to cycle until a complying entry is received.

[0027] Figures 5-7 illustrate examples of preview fields displaying incorrect entries, corresponding assistance message fields displaying corresponding assistance messages, and active input fields displaying complying messages, in accordance with several embodiments of the invention. Beginning with Figure 5, the screen 345 or other display of the first MFD 340a presents a currently active input 549 corresponding to an origin airport from which the aircraft is to depart ("KBFI"). The operator has attempted to update the information in the active input field 348a by entering a preview input 547 containing the characters "A#3BL," which appear in the preview field 342a. The operator has then entered another input signal (e.g., by a click on the cursor control device 380 shown in Figure 3) to submit the preview input 547 for processing and replace the active input 549 with the preview input 547. Because the preview input 547 contains errors, the system 310 does not replace the active input 549 and instead displays an assistance message 546 at the assistance message field 343a.

[0028] The assistance message 546 shown in Figure 5 indicates that the preview input 547 is non-compliant, includes samples of compliant entries, and provides a textual message indicating why the attempted entry is non-compliant. The operator can review the assistance message 546 and understand that not only is the attempted entry non-compliant but that to create a compliant entry, the operator must enter a character string having four characters. By viewing the examples, the operators can understand that the characters should be alphabetic (rather than symbolic or numeric) characters. Accordingly, the operator can re-enter the preview input 547 and, if necessary, continue to re-input the entry until a complying entry is provided.

[0029] In one aspect of an embodiment described above with reference to Figure 5, the same assistance message 546 can be displayed at the assistance message

field 343a regardless of the content of erroneous message received at the preview field 342a. In another embodiment, the assistance message 546 can be tailored to the particular error identified by the system 310. For example, if the preview input 547 contains too many characters, but all the characters are alphabetic characters, the assistance message 546 can be generally similar to the one shown in Figure 5. If the preview input 547 includes non-alphabetic characters, the assistance message 546 can include text indicating that only alphabetic characters are complying. In other examples, if the preview input 547 fails to comply with multiple criteria associated with a complying input, the assistance message 546 can include information corresponding to the multiple criteria. If the preview input 547 fails to comply with only a single criterion associated with a complying message, then the assistance message 546 can include information corresponding to only the single criterion.

[0030] Figure 6 illustrates the first MFD 340a presenting an active input 649 corresponding to an aircraft weight (less fuel) of "340.0." The operator has attempted to update the active input 649 with a preview input 647 having a value of "395.0." This value is out of range for this particular aircraft and accordingly, the system 310 displays an assistance message 646 indicating that the entry is invalid and indicating the range of values the operator can enter to provide a valid input (e.g., a value of from "180.0" to "360.0").

[0031] Figure 7 illustrates the second MFD 340b presenting a blank active input 749 corresponding to the airline code of the subject aircraft. The operator has attempted to provide a preview input 747 corresponding an airline code of "C3D" appearing at the preview display field 342b. This entry does not comply with the standards for a valid entry, and accordingly an assistance message 746 is displayed at the assistance message field 343b. The assistance message 746 indicates that the entry is non-compliant and that a compliant airline code includes two characters. The assistance message 746 also includes a display of sample compliant messages.

[0032] One feature of the embodiments of the systems and methods described above with reference to Figures 2-7 is that the assistance messages provided to the aircraft operator when the operator attempts to input an invalid entry go beyond simply indicating that the entry is invalid or non-compliant. Instead, the assistance messages can indicate why the entry is non-compliant, provide instructions for creating a compliant entry, and/or provide examples of compliant entries. Accordingly, the operator can more quickly, efficiently, and accurately correct an invalid entry, freeing up time to attend to other aircraft management tasks.

[0033] Another feature of embodiments of systems and methods described above with reference to Figures 2-7 is that the display of an erroneous entry is not overwritten by a message indicating that the entry is erroneous. Instead, the assistance message appears simultaneously with the erroneous entry. An advantage of this feature is that the operator can view the erroneous entry along with the assistance message to better understand why the entry is non-compliant and can accordingly generate a compliant entry more easily.

[0034] Still a further feature of embodiments of systems and methods described above with reference to Figures 2-7 is that the assistance message can be displayed not only simultaneously with the non-compliant entry, but also proximate to the non-compliant entry. Accordingly, the operator need not shift his or her eyes a significant distance back and forth between the non-compliant entry and the assistance message to understand why the entry is non-compliant and/or to correct the entry. An advantage of this feature is that it can ease the operator's workload by making the task of entering correct data simpler, less time consuming and less fatiguing than existing methods.

[0035] Yet a further feature of embodiments of the systems and methods described above with reference to Figures 2-7 is that the assistance messages displayed by the system can be tailored to the type of input message received by the system and/or provided to fulfill data requests of a particular type. For example, the assistance message displayed when the system receives an

erroneous airport identifier can be different than the assistance message received when the system receives an erroneous value for aircraft weight. In some embodiments, the assistance message displayed in response to a first type of erroneous input can be different than the assistance message displayed in response to a second, different type of erroneous message received to fulfill the same type of data request. For example, the assistance message displayed when an input airline code has the incorrect number of characters can be different than the message displayed when the characters themselves are of the wrong type. In any of these embodiments, the assistance message can provide the operator with assistance that is more precisely tailored to correct the operator's input error than are existing messages.

[0036] In other embodiments, the inputs can have other characteristics. For example, the inputs can include a character string having an element of data and a modifier corresponding to the data element. One example of such a character string is a runway designation of "25R" (for runway 25 right). If the order in which the operator inputs the data and the modifier is incorrect (e.g., if the operator inputs "R25"), then the assistance message can include an indication that the modifier should be placed after, rather than before the data.

[0037] In still further embodiments, the type of assistance message displayed to the operator can be controlled and/or configured by the end user (e.g., by an airline). For example, the airline may select from a variety of assistance messages, which may vary in the level of detail they provide to the operator, and the airline may select which type of message they wish to have displayed to the operator. In other embodiments, the airline can tailor the language of the message, for example, to include non-English terms and/or to be more intuitive to non-English native speakers. In any of these embodiments, the system can provide a menu of responses from which the airline can select a preferred response, and/or the system can provide the airline with the ability to edit any response. An advantage of this arrangement is that the airline can tailor the type

of message displayed to the operator, based on average operator experience and/or other factors.

[0038] Figure 8 is a partially schematic, forward looking view of the flight deck 812 of an aircraft 811, which provides an environment in which the inputs described above are received, processed and displayed in accordance with an embodiment of the invention. The flight deck 812 can include forward windows 813 providing a forward field of view out of the aircraft 811 for operators seated in a first seat 814a and/or a second seat 814b. In other embodiments, the forward windows 813 can be replaced with one or more external vision screens that include a visual display of the forward field of view out of the aircraft 811. A glare shield 815 can be positioned adjacent to the forward windows 813 to reduce the glare on one or more flight instruments 816 positioned on a control pedestal 817 and a forward instrument panel 818.

[0039] The flight instruments 816 can include primary flight displays (PFDs) 819 that provide the operators with actual flight parameter information. The flight deck 812 can also include the MFDs 340 (described above with reference to Figure 3) for displaying navigation information, assistance messages, flight plan lists and other data. The assistance messages can also be displayed at one or more of the CDUs 330 positioned on the control pedestal 812. The CDUs 330, which can also include the input devices 331 described above with reference to Figure 3, can provide a front end for a flight management computer 820. A mode control panel 821 positioned on the glare shield 815 can include input devices 822 for receiving inputs from the operators, and a plurality of displays 823 for providing flight control information to the operators. The information can also be displayed, entered and/or stored on a laptop computer 825 coupled to the flight instruments 816.

[0040] The operators can select the type of information displayed on at least some of the displays (e.g., the MFDs 340) by manipulating a display select panel 824. Accordingly, the operator can select which of the MFDs 340 presents the preview displays, assistance messages, and active inputs described above with reference to Figures 2-7. In any of these embodiments, the assistance messages can be

displayed in a manner generally similar to the methods described above, and can accordingly provide an efficient, intuitive, and instructive system for receiving and correcting operator inputs.

[0041] From the foregoing, it will be appreciated that specific embodiments of the invention have been described herein for purposes of illustration, but that various modifications may be made without deviating from the spirit and scope of the invention. For example, aspects of the invention described in the context of particular embodiments can be combined and/or eliminated in other embodiments. Accordingly, the invention is not limited except as by the appended claims.